RECTIFIERS
KS-20491 L21, L22, L23, L24
24 VOLTS, 100 AMPERES
LORAIN PRODUCTS CORPORATION
OPERATING METHODS

CONTENTS PAGE

1. GENERAL

1.01 This rectifier provides regulated dc power from a single-phase ac power source for use in charging and floating a 12-cell battery plant. Rectifiers equipped with B and D options will charge and float on 11- or 12-cell battery at full load. Rectifiers equipped with B and D options will charge a 13- or 14-cell battery at 80 percent or rated full load. This rectifier is primarily intended for use in 110A, 111A, 303A, 301C, and 302A power plants. This rectifier is of the ferroresonant type. This type rectifier can provide a relatively constant dc output voltage and may be used whenever the voltage, current capacities, and regulation characteristics meet the requirement with which they will be associated.

1.02 This section is reissued to:

(a) Provide information on options ZK, ZL, ZN, and ZP

(b) Update admonishments to the latest standards

(c) Make other minor corrections.

Revision arrows are used to emphasize the more significant changes. This reissue does affect the Equipment Test List.

1.03 This rectifier is arranged for single-phase, 60 ±3 Hz, ac input and is suitable for use with battery power plants where 3-phase service is not available. The rectifier is adaptable for the following variations:

KS-20491 RECTIFIERS

LIST NO.	INPUT	OUTPUT
L21	208/240V	—24V
L22	480V	—24V
L23	208/240V	+24V
L24	480V	+24V

Note: From 23.87 Vdc to 29.60 Vdc, the rated output current is 100 amperes. Beyond 29.60 Vdc, the rated output current is 80 amperes.

The rated current output is 0 to 100 amperes.

1.04 The rectifier will operate with a permissible input voltage variation of -10 percent to +5 percent about the nominal values. The rectifier is equipped with a low ac input voltage monitor to shut down but not lock out the unit in the event of low ac input voltage. When the voltage restores

to an acceptable level, the rectifier will automatically restart.

1.05 The rectifier utilizes back-to-back thyristors and a KS-20618 regulator to electronically control a ferroresonant transformer for control of the output voltage and current. The output voltage is protected by the external charge fuse (external to the rectifier) and by the current limit feature.

Danger: Voltages inside the rectifier case are over 150 volts to ground. Do not allow a test pick to touch two metal parts at the same time as destructive and dangerous short circuits may occur. Disconnect the alternating current supply before working on the rectifier except when necessary to make tests.

Note 1: The CP2 circuit has been modified to improve possible unstable operation when rectifiers are operated in parallel. CP2 per KS-20618, L2 (A option) is replaced by CP2 per KS-20618, L7 (ZA option).

Note 2: In rectifiers equipped with ZB wiring, the RECT FAIL lamp does not light if the external charge fuse operates. This has been improved by the addition of ZC option wiring and the plant CBS lead. With ZC option, power to operate the RECT FAIL lamp circuit and the HV relay circuit is continuously provided by the plant CBS signal via terminal 15 on the PLANT CONTROL DISCONNECT, J1 connector. Normal operation of these circuits is not affected by this change.

1.06 ▶Rectifiers provided with ZL option have an overvoltage shutdown circuit included that will shut down and lock out the rectifier and activate its failure alarms when the output terminal voltage exceeds a preset level. This level to be set at 29.75 ±0.1 volts.

1.07 Rectifiers provided with ZK option have a fast walk-in reset circuit to minimize transient voltage overshoot when the ac service restores after a service outage.

1.08 Rectifiers provided with ZN option have an automatic restart circuit which will restart the rectifier upon receiving a loop closure signal from the plant if the rectifier has been shut down and locked out by a temporary fault such as transient high voltage.

1.09 Rectifiers provided with ZP option include a modified failure alarm circuit to prevent an RFA alarm and lamp indication when the rectifier is manually turned off.◀

1.10 This rectifier is designed to mount on a 23-inch relay rack framework or in a cabinet with similar mounting arrangements and can be serviced and maintained from the front only. All electrical connections can be made with the front cover removed. The meter, controls, and fuses are mounted on a hinged panel for access, maintenance, or replacement.

1.11 This issue of the section is based on the following drawings:

SD-81997-01, Issue ▶7B◀

SD-82030-01, Issue ▶5B◀

For a detailed description of the operation, see the corresponding circuit description. If this section is to be used with equipment that is associated with an earlier or later issue of the drawings, reference should be made to the SDs and CDs to determine the extent of the changes and the manner in which the section may be affected.

2. LIST OF TOOLS AND TEST APPARATUS

CODE OR SPEC NO.	DESCRIPTION
TOOLS	
—	3-Inch C Screwdriver
TEST APPARATUS	
KS-20538	Volt-Ohm-Milliammeter (or equivalent)
KS-8039	DC Volt-Milliammeter (or equivalent)

3. OPERATION

3.01 The rectifier is completely automatic in the regulation of float voltage and should require no day-to-day routine adjustments. Normally it remains energized and connected to the load. In

addition to manual turn-off, it may be stopped and started by signals from the plant, and will shut down automatically upon occurrence of certain conditions.

3.02 If the load exceeds the safe capacity of the rectifier, the regulating circuit switches to constant current regulation. As the load diminishes, the rectifier brings the voltage to float value and returns to voltage regulation. The voltage at which the rectifier will regulate is determined by the setting of the OUTPUT VOLTS ADJUST (R8) rheostat.

Note: Because some difficulty may be encountered attempting to adjust the output to the precise FLOAT voltage setting of 2.17 volts per cell for plants using 11 cells; the R8 rheostat is changed from a 5K ohms, 2-watt, single-turn type (E option) to a 10K ohms, 2-watt, 10-turn type (D option). The value of resistor R9 is changed from 16.2K ohms (P option) to 12.7K ohms (B option) and the value of resistor R16 is changed from 12.1K ohms (J option) to 11K ohms (B option). With B and D options, the range of adjustment is 23.87 Vdc to 32.80 Vdc. The B and D options must be installed at the same time.

3.03 If it is desirable to CHARGE the battery, the OUTPUT VOLTS ADJUST (R8) rheostat must be rotated cw to shift the operating point of the rectifier from 2.17 volts per cell to 2.20 volts per cell. The office load will then be subjected to the CHARGE voltage.

3.04 The rectifier will provide an OVERCHARGE voltage up to 2.30 volts per cell for a 12-cell battery plant. If it is necessary to OVERCHARGE the battery, the OUTPUT VOLTS ADJUST (R8) rheostat must be rotated cw to shift the operating point from 2.17 volts per cell to the required OVERCHARGE voltage (up to 2.30 volts per cell). The office load will then be subjected to the OVERCHARGE voltage.

Note 1: The rectifier will provide a maximum of 2.30 volts per cell only when the ac input voltage is equal to or greater than the value shown below.

Rectifier Connected For	AC Input Voltage
208V	200V (L21 & L23)
240V	230V (L21 & L23)
480V	460V (L22 & L24)

Note 2: The rectifier will provide 2.30 volts per cell for 11- or 12-cell batteries at rated full load and will provide up to 2.20 volts per cell for 25- or 27-cell batteries at 80 percent of rated full load.

3.05 The rectifier can be tested without disturbing the office load by removing the external charge and charge alarm fuses and disconnecting the plant control cable. It can then be operated in the FLOAT, CHARGE and OVERCHARGE conditions from no load to full load by adding external resistance load across the BAT and GRD output terminals.

3.06 A circuit is provided to simulate an adjustable load up to 125 percent of the output current rating of the rectifier. The simulated output current circuit is enabled only when the SIMULATED OUTPUT CURRENT pushbutton is maintained depressed.

3.07 ***Preparing to Start:*** When putting the rectifier in service, check that—

(a) The POWER ON-POWER OFF (S1) switch is in the OFF position. The POWER OFF lamp is lit.

(b) The plant control cable is connected to the rectifier.

(c) The ac service fuses are installed.

(d) The external charge and charge alarm fuses of the proper size and type are in place.

3.08 ***Starting:*** To start the rectifier, proceed as follows.

(1) Depress the POWER ON-POWER OFF (S1) switch.

Requirement 1: The POWER ON lamp lights.

Requirement 2: ▶The RECT FAIL lamp extinguishes (option ZP not provided).◀

(2) Loosen the locking device and rotate the OUTPUT VOLTS ADJUST (R8) rheostat cw to increase or ccw to decrease the output voltage of the rectifier until the voltage at the battery (as indicated on the plant voltmeter) is the required value. Tighten the locking device for the OUTPUT VOLTS ADJUST (R8) rheostat being careful not to disturb the setting.

Requirement: The voltage at the battery should meet the voltage values specified in the appropriate plant Bell System Practice.

(3) Observe the OUTPUT CURRENT (M1) ammeter to make sure the rectifier accepts its portion of the load. (See the appropriate plant Bell System Practice for voltage and current adjustment of the rectifiers.)

3.09 ***Stopping:*** To stop the rectifier, proceed as follows.

(1) Depress the POWER ON-POWER OFF (S1) switch.

Requirement 1: The POWER OFF lamp lights

Requirement 2: ▶The RECT FAIL lamp lights (option ZP not provided).◀

(2) If the rectifier is to be left out of service for an extended period of time, remove the ac service fuses, external charge and charge alarm fuses, and disconnect the control cable.

Danger: All power should be disconnected before attempting maintenance in the power sections of the rectifier. The battery should be disconnected when the rectifier is shut down for extended periods or for maintenance. Be careful not to short circuit the battery or sensing terminals.

4. ROUTINE CHECKS AND ADJUSTMENTS

4.01 Routine checks are intended to detect defects particularly in infrequently operating parts of the equipment, and insofar as possible, to guard against circuit failures which interfere with service. Checks and adjustments, other than those required by trouble conditions, should be performed during a period when there will be a minimum interference to service.

4.02 Periodically check the output float voltage on the associated power plant voltmeter when the unit is operating on voltage control. If the voltage is not correct, readjust the rectifier float voltage as outlined in 4.05.

4.03 Electrolytic capacitors should be maintained in accordance with Section 032-110-701.

4.04 If the relays are mounted on circuit boards, they can be checked by use of the extender circuit board furnished with the rectifier and must be replaced in case of malfunction. If possible, periodically check all other relays for condition of contacts, making sure that they are in accordance with the circuit requirement table and Bell System Practices which apply.

Danger: When using a portable instrument, the leads should be carefully examined to make sure the insulation is undamaged. The leads should be properly connected to the instrument before making any contact with the circuit to be tested. If connections are to be changed from one instrument range to another, the power should first be disconnected from equipment being tested or, if test picks are being used, they should be removed from the equipment under test.

Note: Before making the following tests or adjustments, remove the rectifier from service by removing the external charge and charge alarm fuses and disconnecting the plant control cable. ▶The LOCAL SNS indicator lamp lights.◀

4.05 ***Output Voltage Adjustment:***

(1) Operate the POWER ON-POWER OFF (S1) switch to the ON position.

Requirement 1: The POWER ON lamp lights.

Requirement 2: ▶The RECT FAIL lamp extinguishes (option ZP not provided).◀

(2) Connect the KS-8039 volt-milliammeter, set to the 30-volt scale to the OUTPUT VOLTS J2 (+) and J3 (-) jacks.

(3) Loosen the locking device and slowly rotate the OUTPUT VOLTS ADJUST (R8) rheostat until the reading on the KS-8039 volt-milliammeter is equal to the battery float voltage requirement at the associated power plant or 2.17 volts per cell if no battery float requirement is given. Tighten the locking device for the OUTPUT VOLTS ADJUST (R8) rheostat being careful not to disturb the setting.

▶***Note:*** When end cell and 2.30 volts per cell charging is required, disconnect the jumper from TP1 and connect to TP2. Restore the jumper to TP1 when charging is completed.◀

4.06 ***Current Limiting Adjustment:***

Note: The CURRENT LIMIT ADJUST (R10) rheostat is factory set for 100 amperes. If it is necessary to readjust the current limit point, proceed as follows.

(1) Turn off the rectifier by depressing the POWER ON-POWER OFF (S1) switch.

Requirement 1: The POWER OFF lamp lights.

Requirement 2: The RECT FAIL lamp lights (option ZP not provided).

(2) Loosen the locking device and rotate the CURRENT LIMIT ADJUST (R10) rheostat fully cw.

(3) Observing ▶proper◀ polarity, connect the KS-20538 volt-ohm-milliammeter, set to the 60-volt dc scale, to the CURRENT LIMIT test jacks (J4 and J5) located on the control panel of the rectifier.

(4) Depress the POWER ON-POWER OFF (S1) switch to start the rectifier.

Warning: Make sure the external charge and charge alarm fuses are removed before operating the SIMULATED OUTPUT CURRENT feature. Depress and hold the SIMULATED OUTPUT CURRENT (S2) switch. The SIMULATED OUTPUT CURRENT lamp lights.

(5) Rotate the SIMULATED OUTPUT CURRENT (R12) rheostat cw until the OUTPUT CURRENT (M1) ammeter indicates the desired maximum output current.

(6) Rotate the CURRENT LIMIT ADJUST (R10) potentiometer slowly until the KS-20538 volt-ohm-milliammeter indicates 1.25 -1.5 volts dc on the 3-volt scale.

(7) Tighten the locking device for the CURRENT LIMIT ADJUST (R10) rheostat being careful not to disturb the setting.

(8) Release the SIMULATED OUTPUT CURRENT (S2) switch. The SIMULATED OUTPUT CURRENT lamp extinguishes.

(9) Rotate the SIMULATED OUTPUT CURRENT (R12) rheostat fully ccw.

(10) Remove the KS-20538 volt-ohm-milliammeter.

4.07 ***Overvoltage Shutdown Adjustment:***

Note 1: The OV ADJUST (R315) potentiometer is factory set to shut down and lock out the rectifier if the output voltage exceeds 29.75 ±0.2 volts. If it is necessary to readjust the overvoltage shutdown setting, proceed as follows.

(1) Turn the rectifier off by depressing the POWER ON—POWER OFF (S1) switch.

Requirement: The POWER OFF lamp is lighted.

(2) Remove CP3 circuit pack, insert extender board into the connector and insert CP3 into the extender board.

(3) Rotate the OV ADJ (R315) potentiometer fully cw.

(4) Connect the KS-8039 meter, set to the 75 Vdc scale, to the OUTPUT VOLTS test jacks, TP1(+) and TP2(-), observing proper polarity.

(5) Turn the rectifier on by depressing the POWER ON—POWER OFF (S1) switch.

(6) Adjust the OUTPUT VOLTS ADJUST (R8) rheostat cw until the meter indicates 29.75 volts.

(7) Slowly rotate the OV ADJ (R315) potentiometer ccw until the rectifier shuts down.

(8) Rotate the OUTPUT VOLTS ADJUST (R5) rheostat fully ccw.

(9) Turn the rectifier on by depressing the POWER ON—POWER OFF (S1) switch to OFF (POWER OFF lamp lights) and then to ON (POWER ON lamp lights).

(10) Adjust the output voltage to the desired level in accordance with 4.05.

4.08 *TR Shutdown Check:*

(1) Using a suitable jumper, connect ground to terminal 7 of the P1 plug.

Requirement: The rectifier shuts down.

(2) Remove the jumper.

Requirement: The rectifier restarts.

4.09 *HV Shutdown Check:*

(1) Using a suitable jumper, connect ground to pin 6 of the P1 plug.

(2) Depress and hold the SIMULATED OUTPUT CURRENT (S2) switch.

(3) Rotate the SIMULATED OUTPUT CURRENT (R12) rheostat cw.

Requirement: The rectifier shuts down and locks out when the OUTPUT CURRENT (M1) ammeter indicates about 5 amperes.

(4) Release the SIMULATED OUTPUT CURRENT (S2) switch.

(5) Remove the jumper.

(6) Depress the POWER ON-POWER OFF (S1) switch twice to release the relays and restart the rectifier.

(7) Rotate the SIMULATED OUTPUT CURRENT (R12) rheostat fully ccw.

4.10 ▶*Overvoltage Shutdown and Lockout Check:*

(1) Connect the KS-8039 meter, set to the 75-volt scale, to the J2(+) and J3(-) rectifier jacks.

(2) Using the OUTPUT VOLTS ADJUST (R8) rheostat, slowly increase the voltage.

Requirement: The rectifier shuts down and locks out when the voltage is between 29.55 and 29.95 volts.

Note: If shutdown occurs below or above these limits, adjust the shutdown voltage in accordance with 4.07.

(3) Disconnect the KS-8039 meter from the J2 and J3 rectifier jacks.

4.11 *Automatic Restart Check:*

(1) Provide a connection between the RS and RSR leads (terminals 4 and 5) of the PLANT CONTROL DISCONNECT connector P1.

(2) Simulate an HV shutdown in accordance with 4.09 except that the SIMULATED OUTPUT CURRENT switch should be released immediately after shutdown occurs.

Requirement: The rectifier automatically restarts approximately 2 seconds after shutdown and lockout.

(3) Simulate a second HV shutdown in accordance with 4.09.

Requirement: The rectifier does not restart until the POWER ON—POWER OFF (S1) switch is depressed twice.

(4) If the rectifier is provided with ZL option, simulate an overvoltage shutdown and lockout in accordance with 4.10.

Requirement: The rectifier automatically restarts approximately 2 seconds after shutdown and immediately shuts down again.

5. TROUBLES

5.01 Refer to Section 169-743-311 for trouble-locating information for KS-20491 rectifiers manufactured by Lorain Products Corporation.